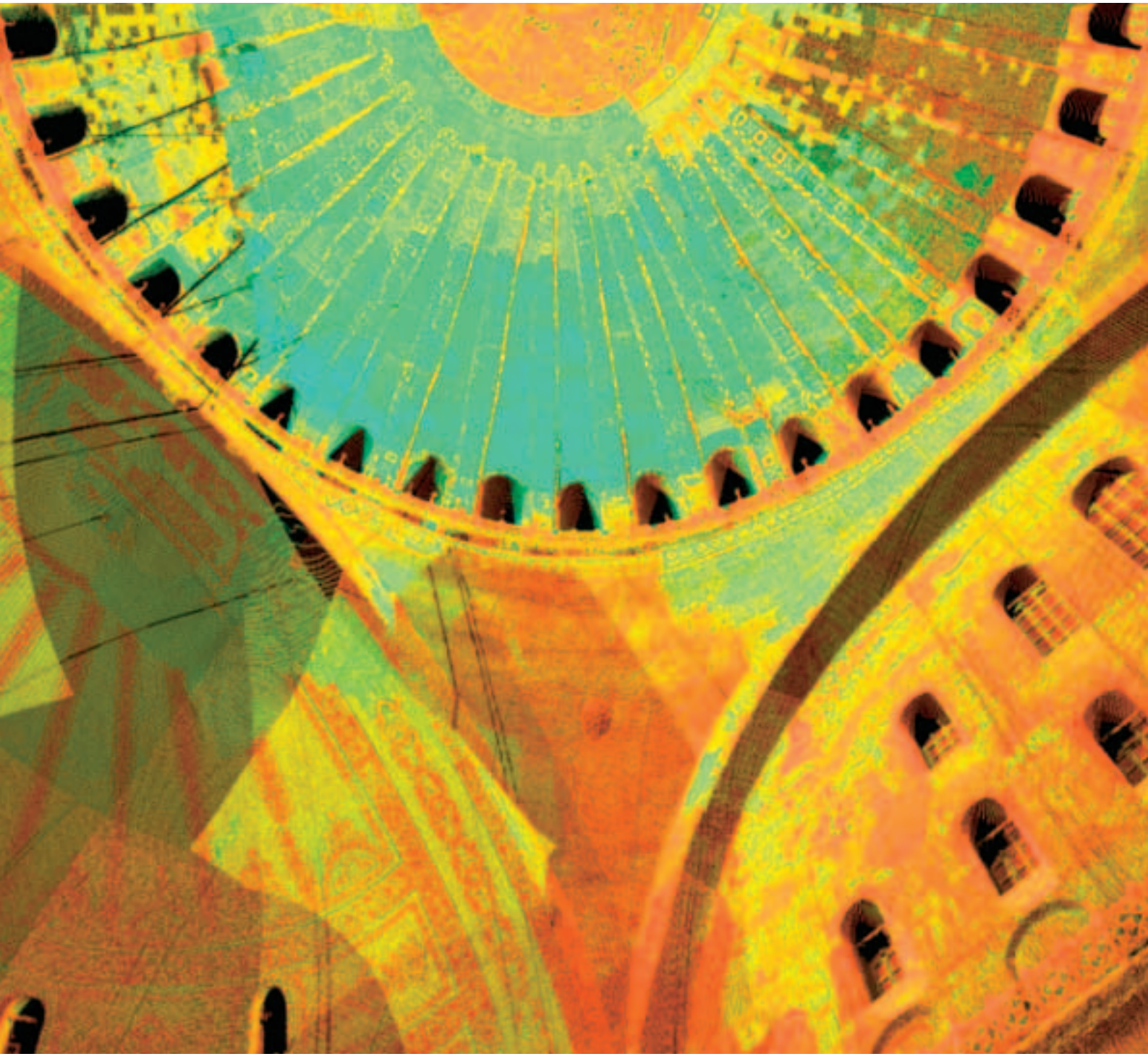
Reporter 52

The Magazine of
Leica Geosystems



- when it has to be **right**

Leica
Geosystems

When it has to be right

Whether building a house or a bridge, a map or a space station, you need reliable measurements. So when it has to be right, professionals trust Leica Geosystems to help them collect, analyze, and present spatial information. With almost two hundred years of pioneering solutions to measure the world, Leica Geosystems is best known for its broad range of products that capture data accurately, model quickly, analyze easily, and visualize and present 3D spatial information. Those who use Leica Geosystems products every day trust them for their dependability, the value they deliver, and the superior customer support. Precision, value, and service from Leica Geosystems. When it has to be right.

It is trust and reliability that characterizes the relationship between Leica Geosystems and our customers. We deliver innovative products and solutions and partner with our customers to add value and increase productivity in the workflow. In this issue of the Reporter you will see many examples of this cooperation from different disciplines and applications. You will see examples of how we have helped our customers speed up the London Underground railway construction, design an international golf course, map the eighth wonder of the ancient world, decipher secrets of a Tanzanian volcano, improve tunnel construction and stadium surveys. You can also read about how our Metrology Division received an award "for excellence in technology leadership within its industry". The Frost & Sullivan Award 2004 for Product Innovation in Industrial Automation was presented to Metrology in October. The "Walk Around CMM" article in this issue provides an insight into how technology teams at Leica Geosystems create solutions you can rely on everywhere and any time. I'm proud of this award because it recognizes the value our customers place in our products and solutions and represents the spirit we have at Leica Geosystems; to support our customers by delivering great products, solutions, service and support.

Hans Hess
CEO Leica Geosystems

Published by: Leica Geosystems AG
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Editor: Fritz Staudacher (Stfi);
Layout: Fritz Staudacher and Niklaus Frei

Publication details: The Reporter is published in English, German, French and Spanish, four times a year.

The publication is printed on chlorine-free paper made by environmentally compatible processes.

Editorial deadline for next issue:
30 March 2005

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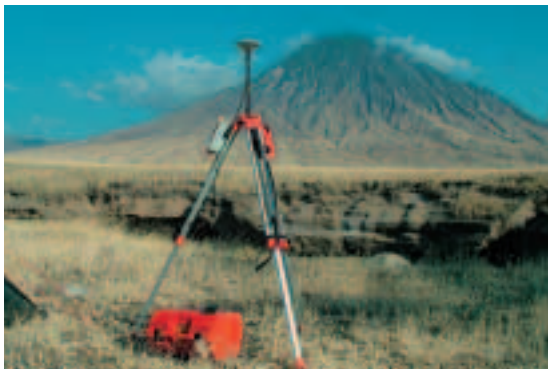

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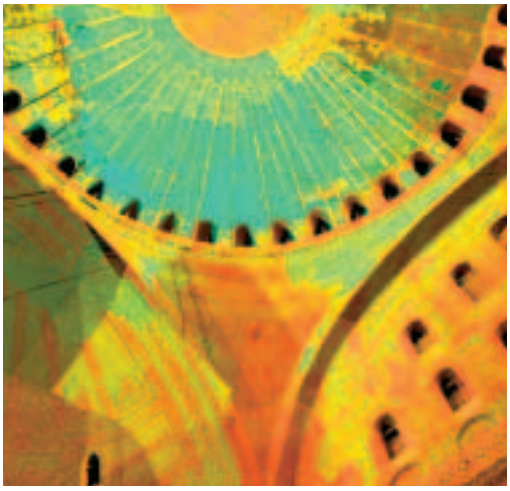

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Young Explorers survey Tanzanian volcano - Ol Doinyo Lengai

Thirty-eight Young Explorers recently took part in a scientific expedition to Tanzania where they used Leica Geosystems equipment to carry out surveys and geoscientific measurements of the active volcano, Ol Doinyo Lengai. The students, part of the BSES Expeditions, completed a gravity survey using Leica GPS530 receivers, as well as a digital terrain model of the volcano and height measurements using the new Leica TCRP1205.

Trekking up Longido as a warm up to the trek across the floor of the Rift Valley.

"The Mountain of God"

Africa's Great Rift Valley has many spectacular sites. In the Gregory Rift south of Lake Natron, northern Tanzania is a unique active volcano. Ol Doinyo Lengai, which means "The Mountain of God" in Mai, the language of the Masai who live in this desolate region, is up against the western wall of the Rift, and towers above it. It is unique because it is the only volcano in the world that erupts natrocarbonatite lava. This looks like very fluid black oil, but rapidly turns white as it absorbs water. In the dry season this can happen over a few days, but in rainy weather the lava turns white immediately. This can give Ol Doinyo Lengai the appearance of being snow-capped.

BSES Expeditions

At two o'clock in the morning on 19 July 2004, 38 Young Explorers, together with nine Leaders, arrived at their camp site in the shadow of Longido, some one hundred kilometres to the east of Ol Doinyo Lengai. These Young Explorers made up a BSES expedition that would walk across the savannah on the floor of the Rift Valley to Ol Doinyo Lengai, then climb its steep flanks before trekking across the Crater Highlands to mankind's birthplace at Oldupai Gorge on the edge of the Serengeti plains.

BSES Expeditions (formerly 'The British Schools Exploring Society') came into existence in 1932 from an educational concept of Commander

George Murray Levick RN, a member of Captain Scott's final Antarctic expedition of 1911 to 1912. The aim of BSES Expeditions is "to provide young people with an intense and lasting experience of self-discovery in a demanding and natural wilderness environment". BSES Expeditions aspire to deliver a once-in-a-lifetime experience that is both challenging and fun. It also develops essential skills in each of the Young Explorers taking part, including leadership, communication and teamwork skills that will help them in the future. Although exploration is a key part of such an expedition, BSES also involves the Young Explorers in scientific activities.

Fires – Ecology, Geoscience and Survey

Aged between 16 and 20, with most on the younger end, these Young Explorers were divided into three "Fires". A "Fire" is a group of 12 or more Young Explorers and two Leaders – a good number to sit round a camp fire!

The largest Fire concentrated on the ecology of the region. Their prime objective was to study the diversity of the vegetation and birds across the Rift Valley and – making use of the altitude on Ol Doinyo Lengai – on the active volcano and on Kerimasi, an extinct volcano nearby.

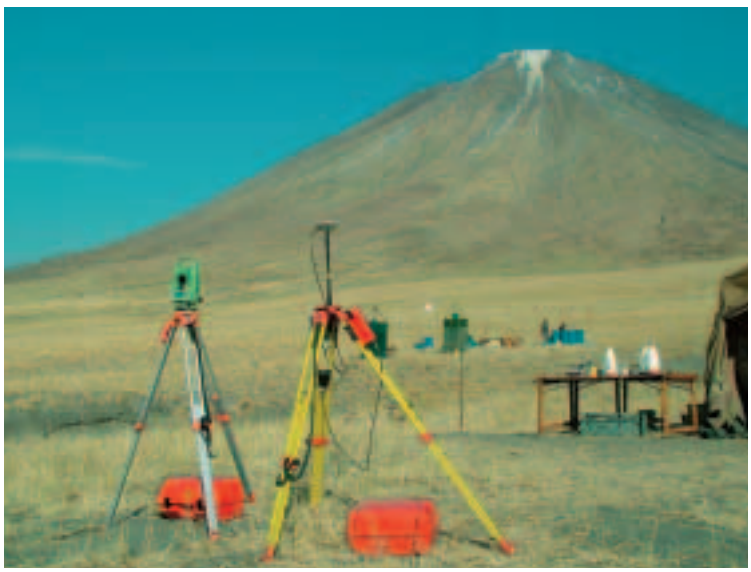
Gravity survey

The two other "Fires", Geoscience and Survey, had activities that were closely related. The main task for the Geoscience Fire was to carry out a gravity survey during the trek across the Rift Valley and on the slopes of Ol Doinyo Lengai. The need for accurate heights provided the Survey Fire with one of its two main science tasks. The gravity meter measures the pull of gravity and the last count on the dial is equivalent to a mere

Gravity meter readings being taken with the position being fixed using the Leica SR530 GPS in differential mode.The Young Explores are also recording the position with an eTrex handheld GPS to compare its accuracy for a navigation position compared with that from the Leica SR530 GPS and the final computed position.

Bottom left: GPS Base Station at the camp at the base of Ol Doinyo Lengai with 12 hour occupation to link the GPS observations into the IGS Stations at Malindi with check observations to Mbarara and the Seychelles. The Leica TCR702 was used to relate gravity meter readings local to the camp to the GPS control.

Bottom right: Backpacking across the savannah with the Leica SR530 GPS. Hanna (one of the Young Explorers) is in front with the battery and Cloin (the expedition Leader) follows with the SR530 GPS.



Plane table surveying around the Kerimasi base camp (Ben and Megan). The Young Explorers benefited from using modern sophisticated Leica Geosystems surveying equipment. They were introduced to plane table surveying as a way of demonstrating the basic principles of making a map.

Plane table surveying around the Kerimasi base camp (Camilla and Ben). Kerimasi, an extinct volcano is in the background with a Masai manyata on the left.

0.03m in height. However, accurately reading this is extremely difficult, so it was necessary to attain relative heights between successive gravity readings of better than 0.1m. In order to achieve this requirement, Leica GPS530 receivers were used in differential mode. Four primary locations were occupied for up to 12 hours and these were computed as base lines back to the IGS (International GPS Service) station at Malindi on the Kenya coast, with checks to IGS Stations at Mbarara in Uganda and in the Seychelles. These provided bases from which differential GPS observations were taken for each location of readings with the gravity meter.

Work in a harsh environment

Leica GPS SR530 receivers proved their worth in this harsh environment and worked faultlessly throughout the expedition despite the heat and dust and the fact that they were being used by inexperienced people. Using check bases and closed traverses it was possible to establish that the precision of the results were better than 0.1m in both plan and height, with many of the points showing much better results than this, so the goal was achieved in an efficient manner. During the course of the expedition the Leica SR530 receiver, aluminium tripod and gravity meter were transported by backpack to some very difficult locations. Not only was it taken to the top of Ol Doinyo Lengai and used to traverse down its precipitous flanks, but it was also taken up the western wall of the Rift Valley to the complete the gravity traverse across the valley floor.

Digital Terrain model of active crater

The other major science project carried out by the Survey Fire was to produce a Digital Terrain Model (DTM) of the active crater of Ol Doinyo Lengai. The ideal instrument for this was the newly launched TCRP1200 with its long-range reflectorless measurement capabilities. A Leica TCRP1205 and lightweight aluminium tripod were backpacked up the very steep path to the crater on the summit of Ol Doinyo Lengai. A strenuous climb of some 2000 metres in altitude, so the light weight of this instrument was a blessing. This Instrument also worked faultlessly in the harsh environment found in the crater of an active volcano again, despite being used by inexperienced people who achieved excellent results after only a short lesson in its operation. The new batteries proved to be a major benefit. Not only were they very light – and thus did not add much to the heavy loads of water and food that needed to backpacked to the top to sustain those staying up there and carrying out the survey observations, but their long life meant that they did not need to be continually brought down, recharged and taken up again. When they did need charging it did not take long, minimising the intrusion of a generator running at base camp.

Determining the height of Ol Doinyo Lengai

Another task performed by the Survey Fire was determining the height of Ol Doinyo Lengai by accurate measurements using the TCRP1205 to a point established using the Leica SR530 receiver relative to the IGS Station at Malindi. This is likely to be the most accurate determination of the height of this mountain ever made, but its value could become superfluous next time Ol Doinyo Lengai erupts. It was established that the summit of Ol Doinyo Lengai has an orthometric height (height above mean sea level) of 2951.6m whilst the GPS or

Our last camp on the rim of Ngorongoro Crater. This is a wild elephant that has wandered into the camp to help himself to fruit that is easily accessible in the camp supplies.

ellipsoidal height was established as 2962.2m. This exercise fits in neatly with the use of Leica SR530 GPS receivers to determine the height of nearby Kilimanjaro as reported in Reporter 44.

The team also took advantage of the GPS measurements to compare the accuracy of a navigated GPS solution compared to the computed result. Being close to the equator, there was good GPS satellite coverage, thought the expedition and the results showed that the navigated positions made with the Leica SR530 receivers were within 5 metres of the computed position in plan and 10 metres in height, although the majority were within 5 metres in height, whilst the Navigated positions provided by the small hand held Garmin eTrex receivers were within 15 metres in plan, but up to 75 metres different in height.

Creating awareness of surveying

The Young Explorers benefited from using modern sophisticated Leica Geosystems surveying equipment. This was offset by introducing them to plane table surveying around the camp to show them the basic principles of making a map – and how easy it is to make errors if care was not taken with setting up and orientation.

The BSES expedition to Tanzania was an opportunity to raise awareness of surveying (geomatics) to young people starting out in life and into their schools as many of the Young Explorers are now back at school, completing their final year before going on to University. This type of activity, along with innovations such as Geomatics.org, which makes surveying equipment (such as Leica levels) available to schools and to BSES Expeditions during the summer months, will bring the surveying profession to the attention of young minds. This safari will be deeply embedded in the minds and remembered fondly, by those that took part, for the rest of their lives.

Hugh Anderson

Ol Doinyo Lengai from our camp near the shores of Lake Natron. As a result of the survey measurements made by the Young Explorers with the Leica SR530 GPS and the Leica TCRP1205 Total Station, we established that the summit of Ol Doinyo Lengai is 2955.3m above mean sea level.

MetroNet brings 21st-century technology to the Underground

ABA Surveying are using laser scanning to capture gauging data ahead of new rolling stock on the London Underground.

Faced with a decision to introduce new trains by the year 2009, MetroNet decided on laser scanning technology to provide the survey data needed to begin the rolling stock design. The problem is that to maximise the size of the train it is necessary to know the size of the gap through which it must pass. The gauging of obstacles such as platforms, bridges, structures and tunnels needs to be known. All railway design and maintenance teams use gauging data, and historical gauging information is available by the drawer full, but the problem is that it can become out of date as soon as it is published. Tracks are continually on the move as a result of maintenance, tamping, settlement and use. For London Underground, a hundred years of maintenance, renewals, additions and modifications have left a bewilderment of cables, lights, signals, electrical boxes and all manner of assets potentially reducing clearances. The problem is made worse by the fact that traditional gauging is, in essence, a profile measured at intervals along the track. Usually the interval will be every 10m or, perhaps, 5m in tight or curved alignments. Unfortunately, anything falling between these regular chainage intervals tends to get overlooked by the traditional profiling survey. MetroNet decided to take a different approach.

Minding the Gap

There are many things which affect the kinematic envelope that a train will describe as it moves along the track. The aspects of data that the geospatial surveyor is required to collect primarily relate to the track position, cant, radius and minimum clearance dimensions to trackside infrastructure that might impact on gauging. These are evaluated against rolling stock design parameters such as the length of coach, the design envelope, the position of the wheels and the wheelbase, suspension characteristics and the design speed – using a software package called ClearRoute.

The package calculates the clearances between vehicles and the infrastructure, and between passing vehicles. It will also calculate stepping distances to platforms. The software can be programmed with the appropriate clearance standards, and be used to deliver Go / No-go or full reported clearance reports. Clearances may be defined in various positions, and according to defined failure-mode conditions. All that is needed is to collect the data for ClearRoute's database. The initial route priority covered in excess of 80 track kilometres and MetroNet had already started four teams of surveyors on the survey of the track position using Leica GRP3000 rail trolleys. Profile data was needed to merge with the track data to complete the input to ClearRoute.

New Technology Provides the answer

Fortunately, the requirement coincided with the introduction of new kinematic scanning technology from ABA Surveying of Woking UK, and after field trials and evaluation ABA was appointed to carry out the work. Their technology is based on the Leica 4500 scanner mounted on a Leica GRP100 rail trolley and collectively known as the GRP5000 system. In this configuration the scanner is mounted on the trolley in such a way that the scan direction is fixed perpendicular to the track. The scan beam rotates at 33 scans per second and is capable of recording 18,000 points in each scan although we only use 10,000 points in this application. Each point of the scan is recorded by the scanner to 3mm RMSE accuracy.

After initialising the start chainage, the trolley is walked along the track at approximately 1 km per hour. At this speed the forward movement is 280mm per second. The scanner measures 33 scans per second; therefore each scan represents a progression along the track of 8mm. Around the arc of the profile points are recorded every 2 - 5mm depending on the distance from the scanner. No detail is too small that it does not get scanned. The result is a point cloud so dense that it looks like a black and white photograph showing details as small as the rivets in the beams. And so it should at an acquisition rate of one point five megabytes of data per second!

Cutting the problem down to size...

Obviously this wealth of data required considerable intelligent thinning to make it useable in anything less than a Cray supercomputer. Part of ABA's task was therefore to

reduce the data to a typical minimum profile corresponding to each 5m chainage. The data for 2.5 metres behind and in front of this chainage was used to create the minimum profile available to the train. In this way what amounted to 600-plus profiles were effectively reduced to just one, but all data was still used. ABA also wrote software to intelligently thin the minimum profile without losing its shape. After much experimenting a resulting profile of some 1200 - 1400 points was considered the optimum solution. A considerable improvement over the 10,000 points originally selected.

...and packaging the results

Finally, ABA had to take the track data provided by MetroNet, attach to it the profile data that had been suitably corrected for cant, add in the obstructions falling between the tracks and then output perfectly formatted ClearRoute files. Again, special software was written to do this and also to output the ClearRoute data in Auto-CAD format for quality checking purposes. Each profile has been visually checked for quality and flyers.

Did it work?

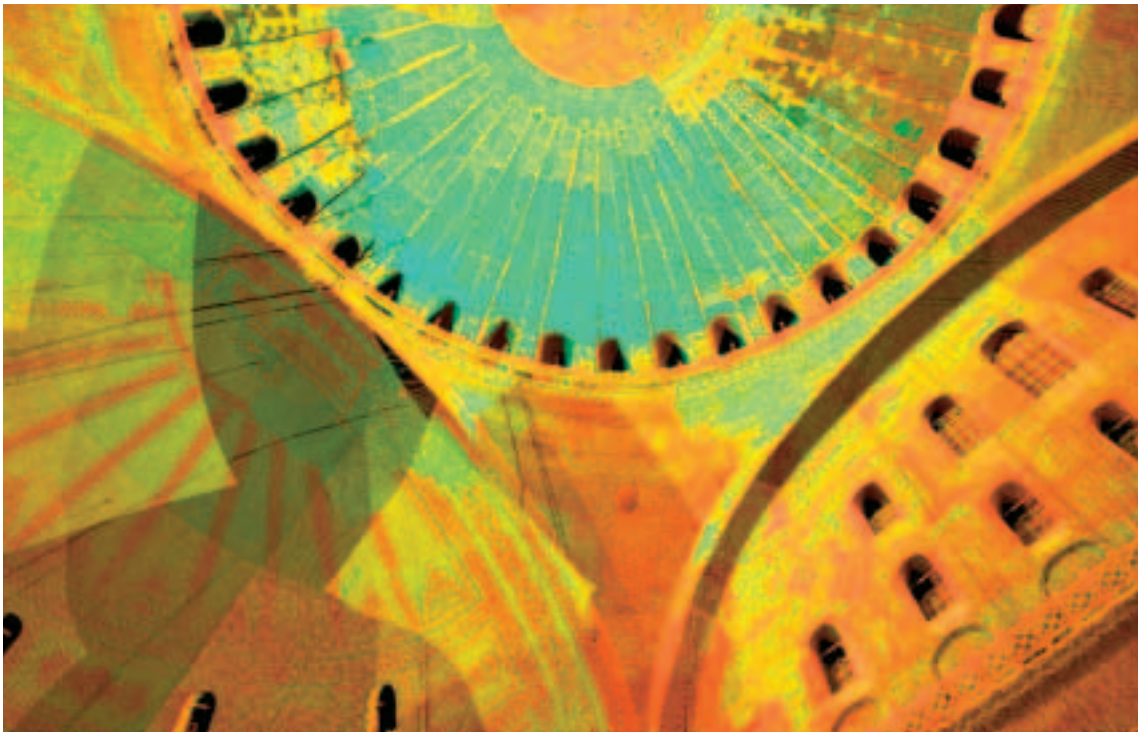
All survey data was captured in five weeks of three-hour "Engineering Hours" shifts. The result is a database of spatial information that includes all visible assets which can be interrogated at any time as required, to precisely measure or position or identify any one of them. If a tight spot is encountered by ClearRoute, the database is there to identify the type of obstruction.

Alan Barrow

On the open track the scanner measures and records all visible detail including trackside and overhead infrastructure. In the scan it has been measured to millimetres.

The Image on the right which has been rendered, is of a station, whilst that below shows the track and a train.

Deciphering the "Eighth Wonder of the World"

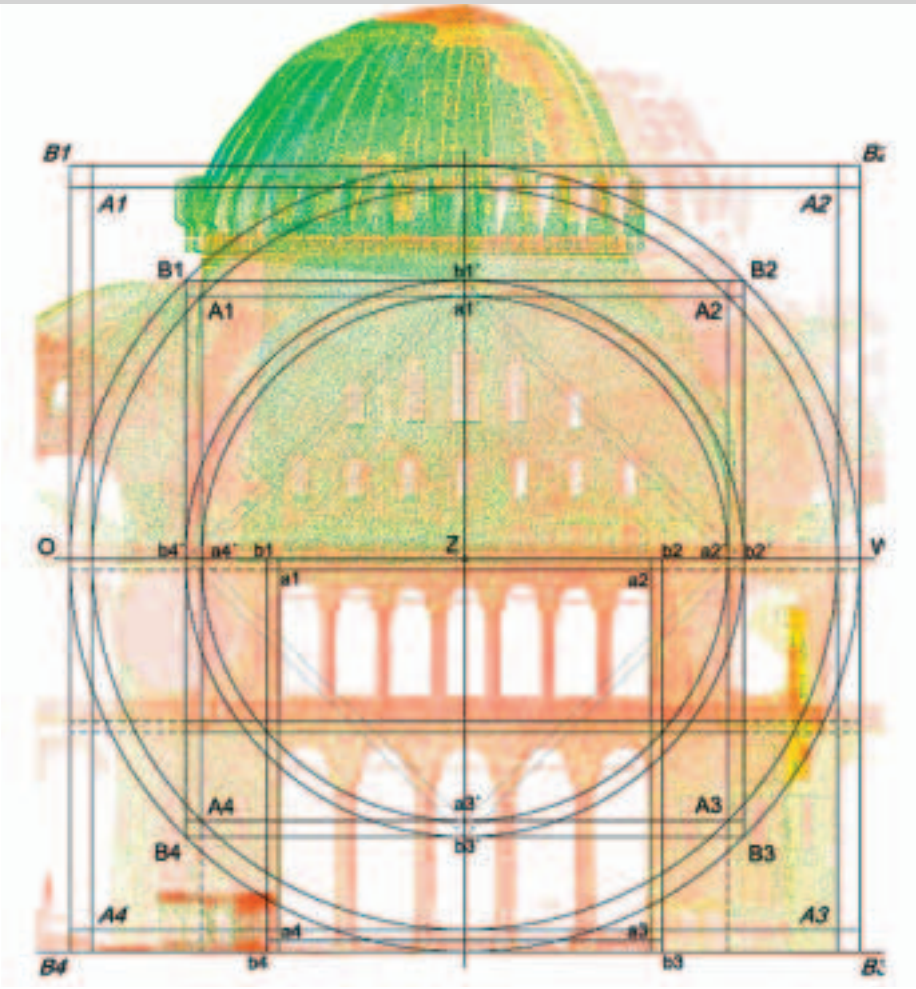


Every point of Saint Sophia's main dome is recorded in 3D in this HDS laser scan file. Using the Cyclone software from Leica Geosystems, it is possible to view and measure the building from various perspectives on the PC.

Almost one and a half thousand years after its construction in the center of ancient Constantinople, Saint Sophia has divulged the secret of its design principle. Volker Hoffmann, professor at the Institute for Art History at the University of Bern, deciphered this using state-of-the-art HDS laser technology from Leica Geosystems. Some of the first laser evaluations went on show for the first time in mid July 2004 in Istanbul at the Congress of the International Society for Photogrammetry and Remote Sensing (ISPRS) and attracted numerous visitors. In mid-October, the Leica HDS3000 was used to record the floors of this building. The handheld laser meter Leica DISTO™ also played an important role at an early stage of the research project.

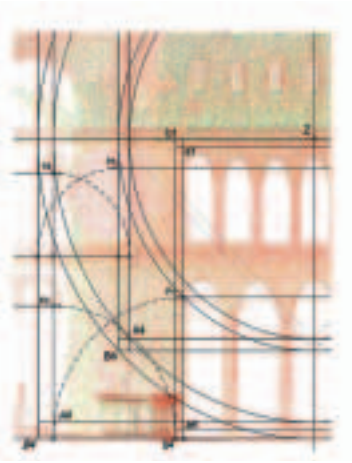
Floating with apparent weightlessness over the main room is the vast dome of the Cathedral of Saint Sophia. Commissioned by Emperor Justitian during the late antiquity period, this UNESCO World Cultural Heritage site is regarded as the eighth wonder of the world. According to the plans drafted by the mathematician Anthemios von Tralles and the architect and structural engineer Isidoros von Milet, the "Aya Sofya", which is now open to the public as a museum, was built in six years during 532 and 537 AD. However, the original plans of this building have been lost without a trace. For hundreds of years, experts have tried to fathom just how the scientists and artists working in the 6th century managed to construct a freely suspended dome measuring almost 56 meters high and 31 meters wide, supported only by four pillars. Considering the technical equipment available at the time

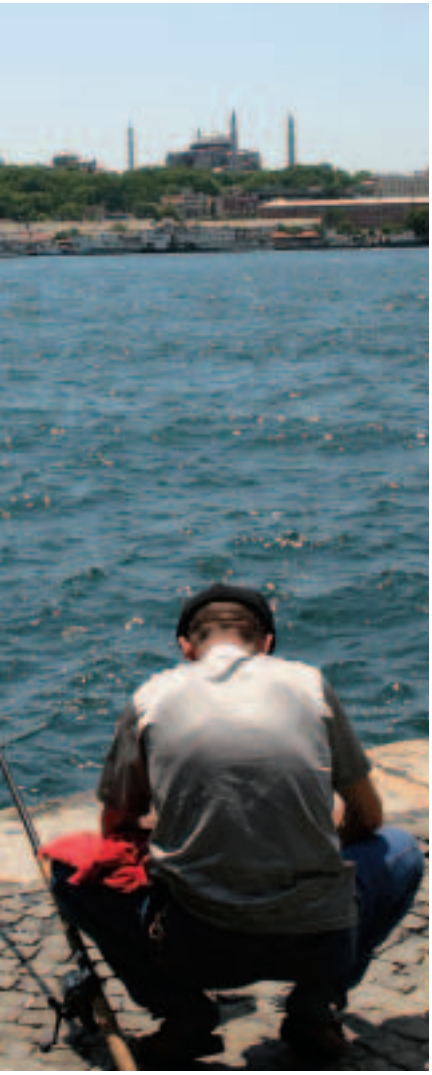
Saint Sophia is scanned with the Leica HDS3000 by Nikolaos Theocharis of Bern University. That day alone this UNESCO world cultural heritage site drew 9'800 visitors in its rooms.



Left: Just like the entire Hagia Sophia, the south wall is also based on the proportions of a double circle and a double square

Below: The pillar heights of the south wall also follow the uniform design principle to the precise centimeter of the "master plan" deciphered by Volker Hoffmann. © Hoffmann/Theocharis





of its construction, many experts still regard this building even to this day as one of the boldest feats of construction ever to have been achieved by the human hand.

The "impossible task" of determining the dimensions

"The key experience on entering the main room through the emperor's gate, which immediately presents itself in full view exposing its full width and height up to the vertex of the huge dome, is the impossible task of finding a clear relationship to the proportions and an accurate calculation of the dimensions" writes the Marco Polo travel guide. This phenomenon, which was intended by its architects, is produced by the spatial structure, the apparent weightlessness of the dome, and the bewildering abundance of direct and indirect

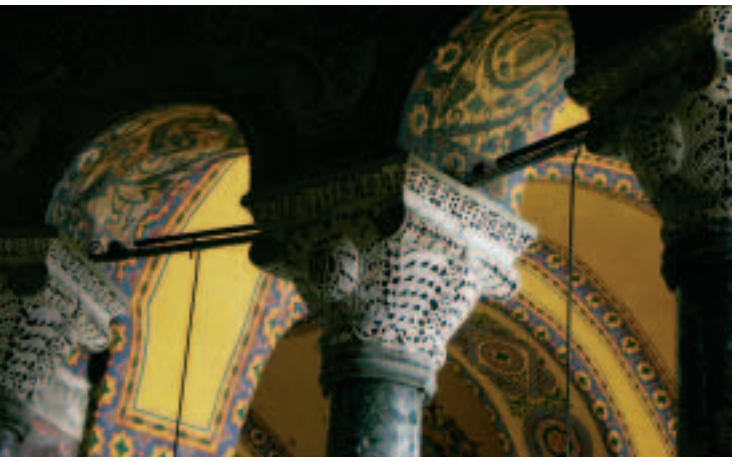
Left: A symbol of Christian and Islamic heritages, Saint Sophia towers above the Golden Horn (photo) and the Bosporus strait connecting Europe and Asia.

Right: Saint Sophia gives visitors an impressive feeling of space.

In the evening, after having closed Saint Sophia for visitors, Professor Volker Hoffmann and Nicholas Theocharis are able to complete their work on the floor. On the left: the Emperors Gate, allowing the most splendid view.

lighting effects. Thanks to the work of the Bernese art historians, insights into these dimensions and their consistent application by the architects and builders of the day are now available.

Below: The finely chased capitals from the Byzantine period also follow the same design principle now uncovered.



Constructional wonder of the world from one to one point zero six

Volker Hoffmann working together with his employee Nikolaos Theocharis in a research project sponsored by the Swiss National Fund found that the entire design of Saint Sophia is based on an analemma. This is a projection technique that was described by Ptolemaeus. This technique made it possible to interconnect the earth and the canopy of heaven in accordance with the view of the world at the time: the sphere representing the sky, god and the church, and the cube representing the earth with its four directions, above and below, and the Emperors real. For Saint Sophia, according to Volker Hoffmann's findings, Anthemios and Isidoros devised an overlapping double-square analemma as a uniform design shape for the ground plan and the elevation of the cathedral, penetrating each other three-dimensionally in the form of a cube and sphere. After performing 3-D laser measurements with the aid of a HDS™ Leica 3000 laser scanner at Saint Sophia, the two scientists from the University of Bern used the technique known as reverse engineering to decipher a "master plan" generated some 1470 years ago. It is based on a ratio of 1 to 1.06 of the small square to the large square. On the basis of the investigations they have performed to date, the researchers have arrived at the conclusion that "there are no layout-related points or lines in Saint Sophia that cannot be deduced from this master plan using geometric logic." The Leica Disto also played an important role. In Volker Hoffmann's words: "Thanks to this compact and highly practical laser measuring instrument, we were able for the first time to determine the precise distances of the four supporting pillars at the simple press of a button. This was highly important at the start of our work for the calculation of the dimensions of the double circle/double square."

The basic distances of the four main pillars have been defined by Volker Hofmann with the Leica Disto™ hand-held laser meter at 31,031 metres, representing hundred Byzantine foot.

Ingenious design principle reconstructed

This design and building principle described by Volker Hoffmann as the "master plan" of Saint Sophia is truly ingenious. "Putting it simply, the master plan was marked out with pegs and strings on the building site, meaning that the builder then only had to measure in the double square, which in turn allowed him to

Each year, over one million visitors admire Saint Sophia, the ancient eighth wonder of the world.

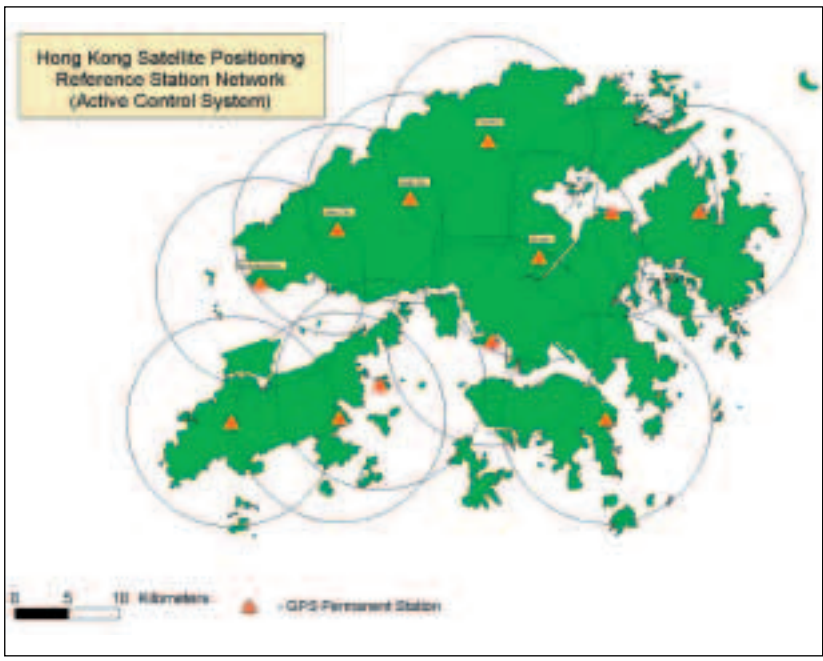
transfer across very precisely all the other points (pegs) and lines (strings and/or lines of bearing) of the Saint Sophia architectural elements", says the professor for architectural history and preservation of historical monuments from the University of Bern. In the second half of April 2005, following the completion of the laser evaluations and after consulting the museums director Mustafa Akkaya, results of this research work are to be presented in the form of an exhibition for the 14 million inhabitants of Istanbul and for the scores of visitors that flock to Saint Sophia. The two thousand-odd photogrammetry and remote sensing experts who travelled to the ISPRS Congress in July 2004 have already gained an insight into this in Istanbul at the Leica Geosystems exhibition stand. The final results are to be presented also in exhibitions in Berlin and Bern. Exhibition sites in the US and in France are also foreseen.

Until now, no one had uncovered the secret of the design principle used in this building, which is devoted to Holy Wisdom, Saint Sophia –at least not until Volker Hoffmann, together with his employee Nikolaos Theocharis, finally succeeded in deciphering it using state-of-the-art 3-D laser measurement techniques some 1470 years later. With is long history as the principal imperial church of early-Christian Greek Orthodoxy, as a mosque, and now as a museum, Saint Sophia represents the history of the Occident and the Orient as no other building can. ***Stfi***

Technology and architecture: laser technology of the 21 th century for the documentation and research of the secrets of the eighth wonder of the ancient world built in the 6th century.

Leica GPS Spider nets Hong Kong

The Hong Kong Lands Department has again partnered with Leica Geosystems to increase their local GPS network to cover the whole Hong Kong area. This major project of the Hong Kong Government's Spatial Data facility aims to extend its network to 12 GPS reference stations fully covering the entire island state.



Map showing the Reference Stations throughout Hong Kong, and their coverage.

Expanding infrastructure

Although only a tiny island state of 1,092 sq km in comparison to its neighbour China, Hong Kong has a population reaching roughly 6.8 million, making it one of the most densely populated places in the world. In the urban areas of Hong Kong Island, there are over 25,000 people per sqkm, and the Government continues to develop and expand its infrastructure throughout the territory.

The latest work contract includes the purchase of 12 units of Leica SR530 GPS receivers for an upgrade of the existing Leica CRS1000 GPS receivers that have been operating since 2000, and the establishment of a further 6 GPS reference stations. In addition, the new system will contain the next generation Leica GPS network software packages – SPIDER and GNSMART – to perform remote operation, data collection, modelling, verification and distribution.

"Satellite positioning is a technology that is becoming very important for the surveying industry," said Simon Kwok, Senior Land Surveyor for the HK Lands Department. "In order to take advantage of this new technology in Hong Kong, we have to set up the infrastructure so that the entire territory can make use of it."

Reference stations accessed every 10km

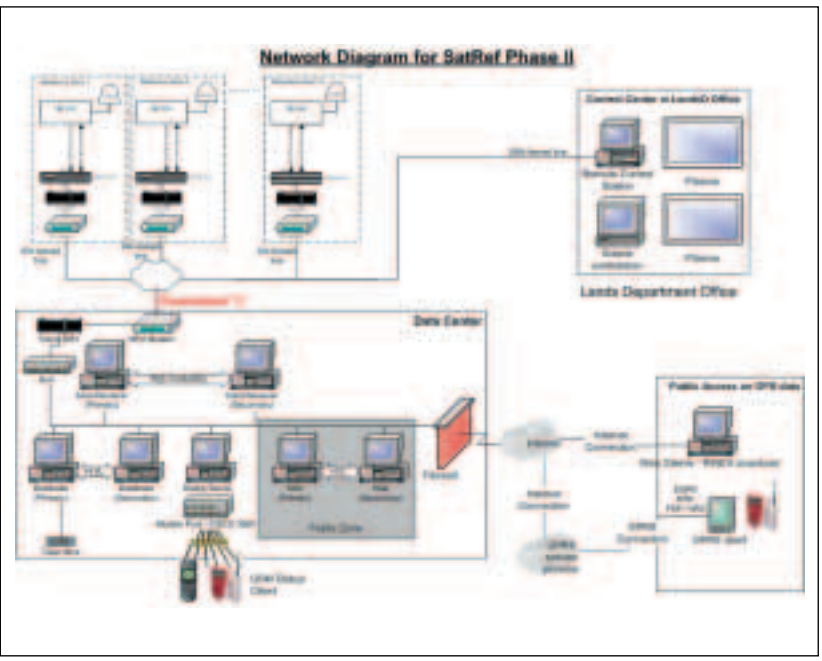
As the configuration will cover the whole of Hong Kong, it will mean that individual surveyors can access at least one reference station within 10 km. In fact, in most cases, they will be able access two reference stations, thus providing two measurements allowing for independent checks of the survey work, ensuring high reliability and quality in the survey results.

"By setting up a Reference Station Network in Hong Kong, normal surveyors can have access to this network and no longer have to set up their own reference stations," Simon Kwok said. "With this infrastructure people can improve the efficiency of their work and therefore reduce equipment costs, personnel and travelling time."

RTK data stream – wireless and over the Internet

The system will generate and distribute atmospheric-corrected RTK data stream for users in the field in Area Correction Parameters (FKP) and Virtual Reference Station (VRS) modes in order to achieve longer range precise RTK positioning. Thus the GPS network will enable various positioning applications to be accurately undertaken in a much more cost efficient manner, thanks to the use of integrity checked DGPS or RTK data streams 24-hour a day, 7-days a week available via wireless communication media such as GSM /

Senior Land Surveyor for the HK Lands Department, Simon Kwok (left) discusses the Reference station project with Eric Pow, Leica Geosystems' Sales and Marketing Manager for Hong Kong.



CDMA / GPRS and also via the Internet.

Meeting the Customer's needs

"We chose Leica Geosystems because they provide a system that suits our need," said Simon Kwok. "Leica has a strong commitment to the customer. They have been able to offer us solutions to suit our requirements and they have responded quickly to develop and build systems that meet our needs."

The first phase of the project was in the northwest of Hong Kong, where a high number of development projects were in progress, such as railway construction. The reference stations will also serve cross-border engineering projects with China, such as bridges and roads. In order to participate in a joint survey with Shanzhen will require that the Hong Kong and Shanzhen control networks be connected. This will save a lot of time and the quality of initial results have proven to be very high. Billing of users is possible for atmospheric-corrected RTK data as well as for conventional RTK and DGPS data delivery through Internet.

Vincent Lui, Technical Specialist, GPS Networks (GSR Asia) of Leica Geosystems said: "The long-term goal of this project is to support land surveying and mapping, but we also see many potential additional uses such as GIS, emergency positioning services, weather forecasting, fleet management and other scientific research."

Training for data processing

Although users are able to use the surveying technology, there can still be some difficulty in processing and assessing the results. In order to solve this, Leica Geosystems has developed web-based facilities for users to submit the raw data to the data centre. "We will receive the raw data, process this data using optimal parameters and then send the results back to the users," said Vincent Lui. "This will greatly aid the users with their data processing and increase their understanding of how to use the software."

Simon Kwok still believes, however, that further education will play an important role in the success of the system. "I still believe that general users need basic knowledge to understand and interpret these results. This is why we hope to conduct seminars to teach people about the system."

Merging ancient and modern technologies

In addition to observing satellite signals, some of the reference station towers will be transformed into sundials and become Hong Kong 'monuments'.

"It is an interesting idea to see here a merging of ancient and modern space technology," said Simon Kwok. "Satellite positioning is a very accurate way to measure time, which in turn determines a position. We can combine this by using the movements of the Sun past the tower that the antenna sits on, to measure the shadow, and hence calculate the time."

"This sort of infrastructure will stay in place for many years, and it will help people remember that humans and nature are working together."

Teresa Belcher

Leica Geosystems-Technical Specialist, GPS Networks (GSR Asia), Vincent Lui, stands by one of the reference stations that will have a dual role as a sundial.

Dependability
Innovation
Trust

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www.leica-geosystems.com

Dimensions we know best

There are more than three dimensions to the data you need to build a house, a bridge, an aircraft or a map.

There is also dependability. You can depend on absolutely reliable measurements and all-round support from Leica Geosystems – whenever and wherever you need them. There is innovation. You get the right solution and the best product – created by people who understand your challenges, and are proud to work for a company that has been pioneering geospatial technologies for over 150 years. And there is trust. In everything we do, that dimension comes built-in.
Three extra dimensions – that's why more companies trust Leica Geosystems to collect, analyze and present spatial information.

- when it has to be **right**

Leica Geosystems

Golf course design and construction machinery guidance with the same 3D data record

The first GPS golf course terrain modeling - the Public Golf Course in Bad Ragaz, Switzerland

Top picture: The Bad Ragaz golf course is located in "Heidi country" between Bad Ragaz and Maienfeld. The section, which has been developed using Leica Geosystems' GPS Dozer, can be seen at the bottom of the photo and in the design sketch.

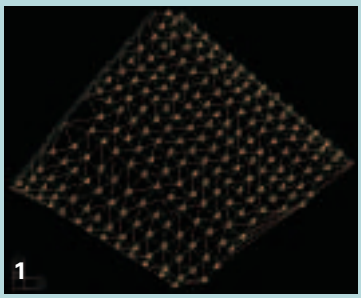
In the context of the research project, "gps rt 3d p - gps and real-time-based 3D planning", the HSR Technical University Rapperswil, Switzerland, achieves golf-course terrain modeling for the first time using GPS in real time. This research project looks into the question of how "earth grading by real-time GPS" might function as part of an overall digital operation for the planning of a golf course. This project is funded by the Commission for Technology and Innovation of the Swiss Federal Office for Vocational Training and Technology.

The new 9-hole golf course was designed by well-known golf course architect Peter Harradine, and nestles in the charming valley of the Alpine Rhine, near to the border between Switzerland and Austria. As a result of the sensitive treatment of the terrain and a new body of water, the project has been slotted into the valley landscape very effectively. The Public Golf Course, with holes totaling approx. 2,000 meters in length, enables even beginners to experience the fascination of golf on the course.

Thousands of regions around the globe are improving the quality of their location by providing a golf course. With over fifty million golfers, the potential of this leisure-time and sporting option is far from exhausted – and it is growing in double percentage figures. As a result of the increasing demand for golf playing possibilities, the Grand Hotels of Bad Ragaz, Switzerland, decided to supplement their 18-hole club course. Golf manager Ralph Polligkeit. "We want to be in a better position to meet rising demand, and also to create playing opportunities for a

Integrated data model

In Bad Ragaz, HSR Professor Peter Petschek and his assistant Yves Maurer have created a start-to-finish digital landscaping process for the first time. A surveyor's office collected the data for the golf course by means of GPS. Colleagues in Peter Harradine's office first produced the analogue draft design using 2D-CAD, and then the 3D digital terrain model using Autodesk's Map 3D. The planners recorded further terrain and vegetation data by means of the Leica GS20 professional data mapping device.
As a result of an optimized (optimised) interface between the programs 3d max and TerrainView, which was also part of the research project, the data were made available for an interactive virtual inspection tour of the planned site. After the landscape architects made some adjustments on the basis of the real-time 3D inspection tour, the planning data was transferred to the Leica Dozer 3D GPS system for terrain modeling with an appropriately equipped bulldozer on site. At the same time the elevation points were also passed directly from Autodesk Map 3D to the Leica GPS machine automation system. This removed the necessity for time-consuming measuring and pegging out on site. At the end of October 2004, in the context of a workshop in front of experts, the landscaping, road-building and excavation firm Toller Ltd. used it to model the terrain on a 10,000 sq m section of the Public Golf Course.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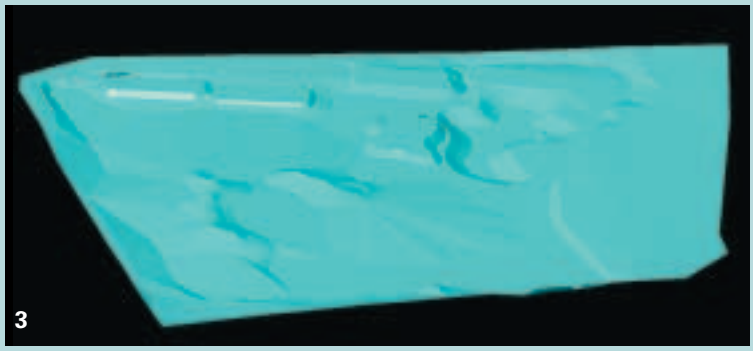
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A closed chain of automation, from data acquisition through virtual 3D design visualization (visualisation) to the guidance data for the construction machine.

1) Autodesk Map 3D site model with the dot matrix and the edges of the test site from the GPS survey of the site.


4

2) Dot matrix of rough grading. This Autodesk Map 3D data record was transferred to the Leica GPS machine automation system.
3) Isometric drawing of the shaded triangulation of the rough grading of the test site.
4) Virtual reality real-time flight through the model of the test site.

wider public in Bad Ragaz, by means of a public golf course." Peter Harradine was given the opportunity to design a 9-hole course, which will be located right next to the existing 18-hole course. This golf course was designed by his father, Dun Harradine.

But how do the initiators and planners develop their projects? How realistically do they present their designs to an environmentally aware public? And how in the end do they translate their plans onto the landscape in technical terms? Such questions are not just of interest to clients, landscape designers, ecologists and experts from the construction industry, but also to geomatics specialists.

Innovative scientists, planners and clients

"To the present day the planning and realization of golf courses is still carried out in the conventional manner – without a uniform data structure and without using the currently available, modern methods of automation," says Peter Petschek, Professor at HSR and head of the research field Information Technology in Landscaping. The internationally experienced landscape architect also follows developments in golf course construction within his specialty, and has been in contact with Peter Harradine for a long time. This dynasty of golf-course designers has achieved an internationally respected name for itself, creating over 200 golf courses worldwide. And the fourth generation is going down the same path, as Peter Harradine's eldest son Michael studies landscape architecture at HSR.

Using the Leica GS20, the landscape architects recorded vegetation data for the data model digitally in three dimensions.

Bottom picture: Marco Riva (right) from construction company Toller Ltd.: "Planners should always provide 3D data records like this. You can make much faster progress that way." Michael Harradine (left) is studying these options for modern landscaping at the HSR Technical University Rapperswil.

Picture left: The fine 18-hole golf course at Bad Ragaz is one of Dun Harradine's creations. The new 9-hole public golf course was designed by his son Peter Harradine. The fourth generation of the family, in the person of his grandson Michael Harradine, is assisting in its digital design and construction.

Qualified data recording with the Leica GS20

The landscape architects struck out in a new direction as soon as they started recording the landscape features, vegetation and terrain of the site to be remodeled into the golf course. To supplement the 3D coordinates recorded at five-meter intervals by the surveyor's office using GPS, they also digitized the terrain and vegetation characteristics using the Leica GS20 GIS/GPS mapping device. This intuitive and handy device also enabled the planner to record qualitative characteristics and to insert items in the GIS database that are of ecological or artistic importance.

After recording the data relating to the terrain, 3D visualization software was used to design the golf course. The scientists from Rapperswil also worked with the Multi-Media-Laboratory of the University of Zurich, with ViewTec and with Autodesk for the purpose of data processing and visualization, as well as with the Federal Office for Water and Geology. The client, the golf experts and the local population were able to view the design in virtual reality from every perspective by means of the 3D fly-through. The data from the same database was also used for 3D-guidance of the construction machinery, and was displayed both graphically and numerically in the cab of the bulldozer or grader. The time-consuming distraction of staking out became unnecessary.

Top picture: The construction machine is equipped with a Leica Dozer system, which determines the 3D position of the blade in real time to the nearest centimeter. The driver of the machine receives all guidance details directly from the system.

Excavators and bulldozers guided by the same 3D data.

A small bulldozer manufactured by Liebherr was chosen for the landscaping earthworks. Volker Kuch of Leica's machine automation division fitted the Leica GPS receiver, guidance and display units to the bulldozer right on site in Bad Ragaz, along with the hydraulic control elements of the Dozer system. The project data supplied by Harradine and HSR were loaded into the guidance software. A Leica System 500 GPS reference station set up outside the construction site supplied correction values for precise kinetic 3D positioning in real time. Without any prior marking out of the site and without any poles to get in the way, the machine operator followed the graphic and numerical details supplied by the Leica Dozer system with extreme 3D precision from the driver's cab of the bulldozer.

The practical expertise of (the) construction company Toller, as a member of the ARGE Golf Toller / Restrukta team, was also crucial for the implementation of these designs on site. Managing director Marco Riva: "The research project proved that it is now possible to model terrain in this way. But the planners must provide the building contractor with reliable 3D data records, as in this case in Bad Ragaz, if the process is to be any more efficient with automated machine guidance. That is still the exception rather than the rule!"

Many earth-moving operations can be more sensibly carried out with an excavator rather than with a bulldozer, so a machine of this type should also be equipped with Leica's automation system for this type of job on larger construction sites. As a result of fine, three-dimensional terrain modeling, smaller models of bulldozers are more suitable for projects such as this than those with wider scoops. Work advances much more rapidly on the site no longer cluttered with marker poles and tapes. Both

Picture left: On a well-known triangulation point outside the golf course construction site there stands a Leica GPS500 as a reference station. It supplies correction data accurate to the nearest centimeter for real-time 3D machine guidance.

time and money are also saved as a result of the significant reduction in the volume of earth moved, on the basis of adherence to the amounts scheduled for removal accurate to within a centimeter.

Ready for everyone to tee-off as early as May 2005

Professor Peter Petschek: "To sum up, we can now say that three-dimensional recording of terrain and vegetation data, using the Leica GS20, offers new opportunities for the landscape designer, and that GPS machine automation can also be employed outside its traditional areas of application such as mining or road-building. The relevant technologies and technical components are available and are already supported by the machines currently in use on construction sites. This is all on the condition that the planners hand over their designs and plans to the building contractor in the form of three-dimensional data records, based on an elevation model of the existing terrain produced by the surveyor."

Fritz Staudacher

In the driver's cab, Peter Petschek sees the results of the research project on the machine operator's display unit. Volker Kuch shows how planning data are combined with the clear guidance data from real-time GPS positioning, providing the machine operator with all the necessary details for the excavation, graphically and digitally accurate to within a centimeter – more quickly, more comprehensively and more precisely than marker poles.

Bottom picture: Michael Harradine (Stud.Ing. HSR), Marco Riva (Toller AG), Peter Petschek (Professor of Landscape Architecture at HSR), Yves Maurer (Assistant, HSR).

UK Surveyors put complete trust in Leica Geosystems

The success story of Leica's System 1200 is continuing, as this report from UK Surveyors illustrates. Leica Geosystems has completed delivery of 14 TPS1200, two GPS1200 receivers, a DNA03 digital level and a HDS3000 upgrade to UK Surveyors, Greenhatch Group. The acquisition of the TPS instruments means that Greenhatch now operate solely with instruments from Leica Geosystems.

"When we heard about Leica's X-function, we knew that we wanted to make use of the system's interoperability," says Neil Jefferies, Managing Director of Greenhatch Design & Development Mapping. "System 1200 gives us greater flexibility, enabling us to use our instruments across disciplines - from our building survey to our land survey group."

Neil Jefferies added that the System 1200's one-man solution and the speed of updating information made their work much more manageable. They were also very impressed with the compact power management and charging accessories.

"With System 1200, there is only one learning curve for TPS and GPS," says Chris Sharrocks, Chairman of the Greenhatch Group. "Following only one day of training, we decided to convert over all the instruments on just one day. We went out on site and couldn't believe how smoothly it all went. We encountered very few problems because the instruments are just so easy to use."

Greenhatch Group specialise in using multiple crews on site in order to collect data as quickly and as efficiently as possible. "Clients know that they can rely on us for quality of information and know that the work will get done in the required timeframe, no matter what," Chris Sharrocks says.

"Bearing that in mind, we are only as good as the people who back us up, and Leica Geosystems certainly do that - providing first class personal service whenever we need it."

The new instruments complete the company's recent image overhaul following a re-design of their logo and a move into new refurbished premises, that have been specifically designed to accommodate the Leica equipment and to enable staff to perform with the highest efficiency and productivity. In addition, a piece of artwork also hangs in the main stairwell of the new offices, which was commissioned to represent the excellent relationship that exists between Greenhatch and Leica Geosystems.

Greenhatch have replaced all existing instruments with Leica Geosystems stock. Above: Mark Concannon, VP of Leica Geosystems' S&E Division for Europe/Africa, and Greenhatch Chairman Chris Sharrocks with the new mosaic in the background

"The confidence that Greenhatch have in Leica Geosystems is yet another important validation for the new generation System 1200 technology," says Mark Concannon, Vice President of Leica Geosystems' Surveying and Engineering Division for Europe/Africa.

"Following only one day of training, we decided to convert over all the instruments on just one day. We went out on site and couldn't believe how smoothly it all went."

Chris Sharrocks, Chairman Greenhatch Group, UK

Additionally, the arrival of the HDS3000 Scanner has come at an ideal time, as Greenhatch are working closely with various heritage and archaeological groups.

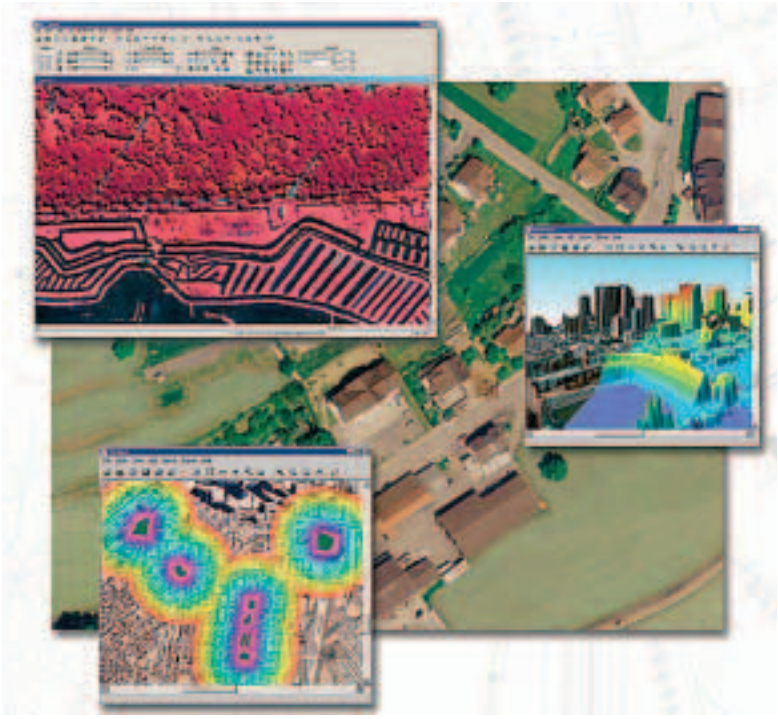
Robert Page, Managing Director of the Building Surveys division, explained: "Greenhatch Building Surveys have always found that Leica equipment lends itself well to measuring buildings. The HDS3000 and pin point reflectorless measuring of the 1200 series, enables us as a company to undertake more complex structures with greater ease and accuracy."

Robert's colleague, Andrew Dodson, who has developed a good working relationship with heritage organisations is looking to break new ground with the integration of HDS 3000 and third-party software to develop the use of photo rectification and photogrammetry.

"Forming new divisions within the group has enabled us to pursue and offer our clients alternative ways of surveying and therefore more variety in products we can issue."

The Greenhatch Group, based in Derby in the UK midlands, manages three companies with nearly 50 employees. The company specialises in the areas of: Design & Development Mapping, Building Surveys and the newly established 3D laser scanning. Their client base of over 2000 ranges from multinational companies to local architects, and jobs are undertaken throughout Europe including the UK, Spain, Northern Europe, Belgium, France, Gibraltar, Poland and Russia.

GIS software supply agreement with U.S. Forest Service



Leica Geosystems GIS & Mapping division has signed a blanket purchase agreement (BPA) for Leica Geosystems software with the USDA Forest Service. The Forest Service is standardizing on Leica Geosystems imaging processing and photogrammetry software, joining a growing roster of organizations that recognize Leica Geosystems as the premier provider of geospatial imaging solutions.

Through this agreement, the Forest Service will employ the full complement of Leica software products, including Erdas Imagine®, Leica Photogrammetry Suite, Imagine Virtual GIS®, Image Analysis™ for ArcGIS, and Stereo Analyst® for ArcGIS. The software will be utilized by Forest Service field units in nearly every forest management application, including forest planning, inventory, resource mapping, fire monitoring and management, and forest restoration.

"The USDA Forest Service is pleased to continue its long relationship with Leica Geosystems through this new five year BPA contract for image processing software. The field units will benefit greatly from the expanded availability of Leica Geosystems products and number of licenses," says Michael Morrison, Program Leader for the USDA Forest Service Image Processing Software System.

Richard McKay, Vice President of Sales for Leica Geosystems GIS & Mapping adds: "We are delighted to expand our relationship with the Forest Service. This BPA is the largest single commercial software order our Division has fulfilled. It is a tremendous vote of confidence in Leica Geosystems software, and this builds our momentum as the preferred provider of solutions for every link of the Geospatial Imaging Chain."

151 units of System 1200 supplied in Western Canada

With sales of 151 System 1200 GPS units in fall 2004 in Western Canada alone, the success of Leica Geosystems' universal surveying system is continuing also in the Americas. "These large orders represent an important validation of Leica's System 1200 technology for demanding applications in one of the harshest environments on the face of the planet," says Rick Kurash, President Spatial Technologies, a Leica Geosystems' distribution partner in Alberta. "Leica Geosystems is quickly establishing a reputation as the premier supplier of dual-frequency survey-grade GPS receivers for the industry, due to the products' reliability, robustness, quality and performance in the field."

A total of 151 units were ordered by several well-known survey companies with the largest single order coming from Wolf Survey and Mapping, a division of Destiny Resources. Other major companies purchasing similar System 1200 packages include Enviro-Tech Surveys, Raymac Surveys, Seisland Surveys, and Datum Surveys. They are being used for staking out seismic lines, setting survey control and other applications.

"One reason for the success of the System 1200 GPS products in the Canadian surveying industry is the accurate and complete quality control information displayed," noted Kurash. "This ensures maximum productivity while maintaining the required precision."

Leica Geosystems' instruments play key role in Sydney's biggest ever infrastructure project

The A$ 2 billion Epping to Chatswood Rail Link, that is being constructed though the most densely populated suburbs of Australia's biggest city, is using top-of-the range equipment from Leica Geosystems. Total stations TCA1101s and TCRA1101s as well as the DNA03 Precise Digital Level are being used for general tunnel surveying while the TCA1800s are being used to guide the giant tunnel boring machines and road headers to ensure the accuracy of the tunnelling.

The project, undertaken by Thiess Hochtief Joint Venture (THJV) is the largest publicly funded infrastructure project in New South Wales and a key part of the NSW Government's infrastructure plan – aiming to help meet the challenge of a growing population (growing at a rate of 1000 people a week). The project will also provide considerable long-term environmental benefits to Sydney by reducing traffic congestion and therefore improving air quality.

The cuting edge of one of the Tunnel Boring Machines

Hochtief expertise

Previously located in South Africa, Dieter Schuerenberg, Chief Surveyor from Hochtief, and his team were brought especially to Australia to work on the project due to their expertise in tunnelling and TBMs. Hochtief is one of the world's leading tunnelling contractors and has produced an innovative technical solution for the project that focuses on safety, environmental management and community relations. Currently, 7 out of 15 Hochtief Surveyors (tunneling specialists) are working outside of Germany on different projects.

Twin Tunnels

The main component of the Epping to Chatswood Rail Link will be 13 km of twin tunnels, which includes four stations, at depths of 25-40 meter. These underground stations are being excavated using road header machines and are accessed with decline tunnels.

Excavation of the new underground stations, located at Epping, Macquarie University, Macquarie Park and Delhi Road, began in February 2003. All are now completed and consist of cabins of 23 meter wide, 15 meter tall and 220 meter long.

Tunnel construction process

Two 215 meter long Tunnel Boring Machines (TBMs) each of 7.2 meter diameter were then launched from the M2 Shaft to carve through the Hawkesbury Sandstone. The segment from M2 Shaft to Epping was completed in July 2004, and the TBMs have been completely pulled back and re-launched at Delhi Road to bore in the opposite direction to Chatswood. A conveyor belt runs through the entire tunnel to remove spoil, and depending on progress, each TBM can advance up to 60 meter per day.

"As the tunnels are constructed, horizontal stresses and tension can occur," Dieter Schuerenberg says. "Default zones are set up with special supports and anchor drillings to minimize this impact.

"In addition to the network behind the TBMs, gyromat measurements are taken and calculation are performed to check the direction underground until breakthrough of the TBMs. With the installed tunnel guidance system the operator examines all the monitoring data in order to steer the TBM along the designed center line within the given tolerances."

Currently, the survey teams using seven TCRA 1101s for normal day work and six TCA 1800s for tunnel guiding systems on the TBMs and road headers. This will be increased when another team is brought on board.

As the TBMs progress, each 35 – 60 meter a "short move up" is undertaken, to install a new theodolite position on a wall bracket. At any one time, there is a minimum of two

Dieter Schuerenberg, Chief Surveyor from Hochtief

A Leica TCRA1101 is set up on a bracket to monitor the tunnel construction

brackets installed in order to monitor the excavations. Every two to three days, however, a "long move up" is performed where the position of the TBMs is measured from network behind the TBMs.

Software for every aspect of surveying

On-board software includes "Road Plus", "Sets of Angles", "Free Station", "Stakeout", "TMS Proscan", "Leica Survey Office" and "TMS Prowin", which cover every aspect of the surveying operation, from rock-face to business integration.

Tunnel completion

When each tunnel segment is completed, it is ready for a concrete lining, then installation of the track, and finally application of the stage concrete. It is anticipated that the final excavation will be completed by June-July 2005, and that following the complete lining and final checks, the entire tunnel will be ready in May 2006.

Environmental considerations

"This project has involved significant environmental consideration and public consultation, particularly with regard to crossing the Lane Cover River," Schuerenberg says." The decision to construct a tunnel rather than a bridge was made in response to widespread community concern. A cut and cover tunnel will be built approximately one meter below the riverbed. This will reduce the long-term visual, environmental and amenity impact on the Lane Cove National Park and River Valley."

Because construction and boring is being undertaken 24 hours per day, noise monitoring is required around-the-clock. Residents are also kept completely informed of construction progress that is undertaken close to them.

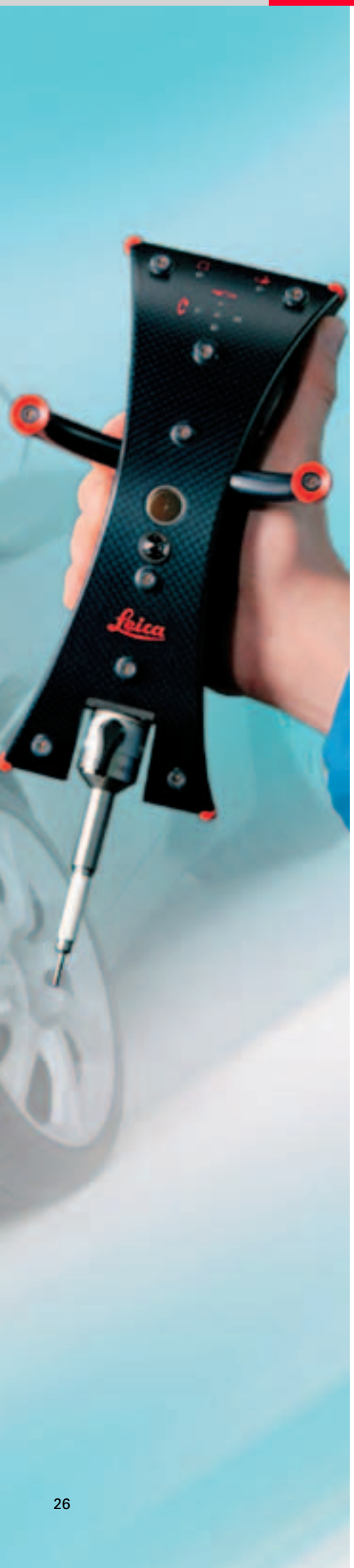
Great service and precision

Every two months, THJV undertake their own calibration of the instruments. In addition, every six months, Leica Geosystems' Australian Distributors, C.R.Kennedy & Company complete a comprehensive service. "We have been extremely happy with the great service we receive from C. R. Kennedy," Schuerenberg says. "We are also completely happy with the precision of the instruments and have had no reported breakdowns."

Hochtief in Germany have changed now to the new TPS System 1200. "On the current rail line job, we will continue to use the existing TPS 1100 instruments for data consistency," Dieter Schuerenberg says. "However, for our next project, we will use the new system."

Teresa Belcher

Map showing the route of the Epping to Chatswood Rail Line



The Award Winning

Driven by customer requirements and based on Leica's existing technologies used for camera-equipped automatic theodolites Leica Geosystems has developed a new three-dimensional measuring system. Our Metrology division is now able to address not only typical laser application segments such as in tooling but also parts inspection and digitization applications in the aerospace, automotive and general precision industries.

Dr. Roland Zumbrunn, Vice President and head of R&D, and Walter Mittelholzer, President Leica Geosystems Metrology Division, at the Frost & Sullivan Industrial Automation award ceremony on October 20, 2004

Walter Mittelholzer, President of the Metrology Division, says: "As a result, we now have a new portable coordinate measuring solution – the walk around CMM T-Probe. This product has proven to be more efficient and more accurate than comparable solutions". He continues: "The division's new solution was well perceived by our customers and enabled especially automotive manufacturers to significantly improve efficiency and accuracy in their inspection processes. And last but not least, this new technology of Leica Geosystems received the prestigious Frost & Sullivan '2004 Industrial Automation Product Innovation of the Year Award'. The New York-based company said the nomination recognizes Leica Geosystems' position as the company that had most clearly shown "excellence in technology leadership within its industry" – most recently in the area of hand-held industrial metrology applications.

Dr. Jürgen Dold, Vice President and Head of Product Management

The innovative hand-held probing device T-Probe is Leica Geosystems' first product that has been introduced to the market based on the Local Positioning Technology. It is the world's smallest and lightest precision coordinate measuring system for large measurement volumes of up to 30 meters. Dr. Jürgen Dold, Vice President and Head of Product Management says "This innovation will change the way people measure industrial structures, by enabling operators in the automotive, aerospace and general precision industries to walk around with this light and wireless T-Probe and compare tools and parts in real time against CAD design data. Compared with conventional portable CMM solutions, Leica Geosystems' new "Walk Around CMM" reduces inspection times by up to 50%,

“Walk Around CMM“

with enhanced accuracy, leading to significant productivity improvements for our customers. With the T-Probe, the Metrology division can now address a myriad of new applications in the industrial inspection market.

The new T-Probe system is based on the division’s newly designed Local Positioning Technology (LPT). The basic concept of this Local Positioning Technology is that one base station determines the location and orientation of a freely in space moved hand- or machine-held device. It consists of a state-of-the-art Leica Laser Tracker for position measurements and the newly developed high-speed camera T-Cam for precise orientation measurements. The combination of this base station with various hand or machine held devices such as T-Probe and T-Scan enables the Metrology division to create an entire range of new portable metrology solutions.

Dr. Roland Zumbrunn, Vice President and head of R&D says: “The key challenge for R&D was to develop a tracker – camera – probe system that measures and synchronizes orientation angles and position of a hand-held device over the whole measurement range with the similar accuracy, speed and robustness that customers are used to get from Leica’s Laser Tracker Technology. This project challenged the whole development team in every field. It was our division’s biggest project ever. We had the chance not only to develop a great product but also to make significant improvements in process- and project management.”

The project involved a majorjty of R&D resources within the Metrology Division. External partners delivered around 20% of the required developments.

Only people make it happen. Walter Mittelholzer, President of the Metrology Division, is proud of his team: “I want to thank all employees for their efforts and contributions in bringing this new product to the market. They have worked very hard over the past few years, sometimes at night, over weekends or during their holidays. Their dedication and brilliant ideas have made it an outstanding product which will revolutionize the metrology world.” We want to thank and congratulate all the team members who eventually “made it happen“.

2004 FROST & SULLIVAN
Industrial Automation
Product Innovation of the Year Award

Leica T-Scan

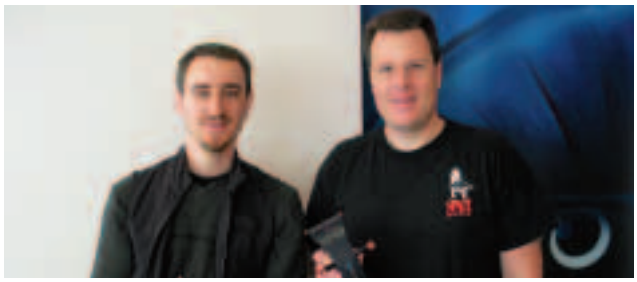
Leica T-Probe

Mechanical Design Group: **Markus Fäs, Daniel Hirter, Dieter Hoffmann, Bernhard Hauri**

The mechanical design group proposed to make use of new materials to increase stability, durability, accuracy and ease of use. The T-Cam is based on a light but very stiff and stable titanium frame and the optical design was chosen so that frequent calibrations of the T-Cam became obsolete. The newly invented and very unique vario-optic ensures that measurements with hand-held devices such as T-Probe will be equally accurate whether it's in small or large measurement volumes. New materials were also chosen for the hand-held probe. A carbon fiber composite based material was used to manufacture the body of the T-Probe. With this choice the T-Probe became not only the smallest and lightest walk around CMM, it also became shock resistant and very stable under different environmental conditions.

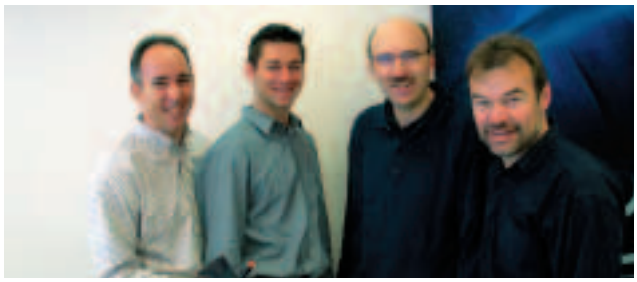
Electronic Team: **Martin Stampfli, Konrad Von Arb, Rolf Döbeli, Hans-Ueli Minder, Konrad Wildi, Beat Hunziker, Tomasz Kwiatkowski**

Our electronic team faced several challenges. As always, new measurement technologies are full of electronic components. One of their achievements was the outstanding innovation of the communication concept, which allows wireless communication of our T-Probe system. In addition, they introduced intelligent stylus identification, reducing operator errors to a minimum. This enables easy to use and walk around freedom with the hand-held probe, eliminating the need for awkward cables. They also developed technologies for high-speed operations and calculations with the new camera T-Cam, permitting up to 100 point measurements per second.



Calibration Team: **Andreas Christen, Albert Markendorf**

The development of a compensation model for the newly invented vario-optics, including calibration methods and related tools, was a major challenge for our calibration and measurement laboratory team. Furthermore the mathematical relation between the Laser Tracker, the T-Cam and T-Probe had to be formulated and related compensation methods suitable for on-site operation had to be made available. Various calibrations and test measurements were conducted in countless hours with a large number of prototypes to verify the performance and reliability of all system components as well as of the entire T-Probe system. Last but not least, this team transferred its know-how to the production, service and support teams.

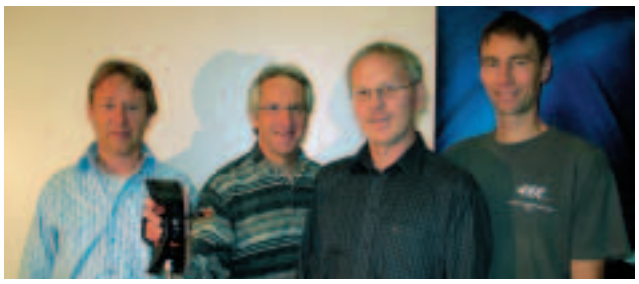


Product Management Team: **Daniel Moser, Pirmin Bitzi, Thomas Rietze, Dr. Raimund Loser**

Besides the R&D teams, many other teams were involved in bringing our new T-Probe system to the market. Under the leadership of the product management team, internal and external beta testing with key customers were performed to furnish the final proof that the system is ready for release. The supply chain team is in the process to ramp up the production for high quantities, ensuring fast delivery with the quality customers expect from Leica Geosystems. Several marketing initiatives were launched under the leadership of our marketing team in close cooperation with the sales organization to increase market awareness for our new "Walk Around CMM" with our existing customer base and also with new customer segments. The support and service team completed intensive system testing as well as training for our global sales representatives. The support and service organization will ensure high-quality service for our customers around the world.

Project Managers: Alexander Stieger, Dr. Manfred Küpfer, Dr. Raimund Loser, Dr. Alfons Meid, Dr. Burkhard Böckem

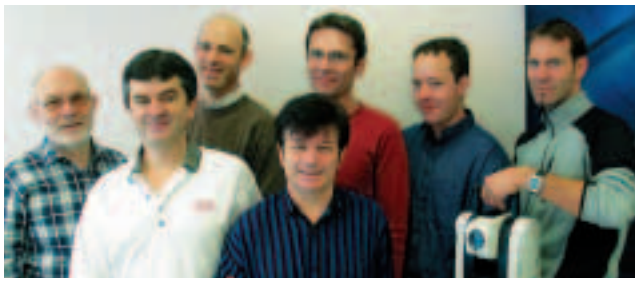
The key task for the project managers was the management of multiple teams from different disciplines to ensure that innovative technologies were developed according to project plans and that each single project was focused on the overall completion of a new innovative optical coordinate measuring system. In this process we have significantly improved our project management skills, meeting and reporting culture, and applied the Leica Innovation Process in a pragmatic way.



emScon Team: Andreas Brönnimann, Werner Stähli, Urs Wigger, Dr. Martin Flucher

Any measurement sensor requires software that opens the hardware functionality for industrial applications and supports field checks and calibration processes. With emScon (embedded system control), a very unique web based interface was created. The on-board Tracker Programming Interface (TPI) enables any application software to fully control the Leica Tracker, supporting C, C++ and COM interfaces. The plug-in Base User Interface (BUI), based on a client server concept, enables users to control the laser tracker via a standard browser like the Internet Explorer. The ease of use of this interface with the complete programming documentation and training courses allows the Metrology Division to connect its new system to many different application software so that customers are able to use the new system with the software they are standardized on. This facilitated a fast market entrance into many new customers segments.

Service and Support Teams: in the back from left to right: Markus Steiner, Gerald Köck, Christian Joray. In the front from left to right: Adrian Renold, Matthias Saure, Roland Schötzau



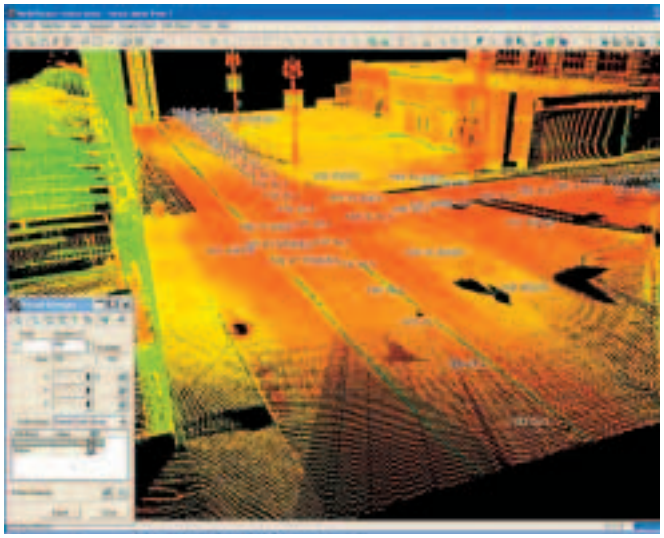
Udo Röhler, Risto Lazarevic, Dave Koster, Peter Dössegger, Roland Strub, Sven Ryser, Dieter Hartmann

The market acceptance of the new “Walk Around CMM” T-Probe and T-Scan is extraordinary. This new product has made it possible to enter new market segments such as the automotive industry. Today about half of our customers are in the automotive industry and many of them are evaluating the replacement of their existing metrology system with the T-Probe to improve efficiency in their production processes.

2004 FROST & SULLIVAN Industrial Automation Product Innovation of the Year Award

New Leica HDS3000 Lifts Scanning into Everyday Use for METCO Services

Metco Services has dramatically increased its use of laser scanning for topographic surveys, thanks to its new Leica HDS3000 scanner



METCO uses Cyclone software's Virtual Surveyor feature for creating 2D maps.

Metco Services is a progressive civil engineering and surveying company based in Detroit, Michigan. The company maintains approximately seven survey crews from two offices that provide topographic surveying and construction staking services. The company recently began using their new Leica HDS3000 for everyday topographic, as-built, and site surveys. Previously, Metco had used laser scanning only for selected topographic surveys with special requirements. The move up from specialized use to everyday use of high-definition surveying portends a bright future for the technology and for Metco.

Leica HDS3000 sharply reduces field time and field staff needs

One key reason for the dramatically increased deployment of high-definition surveying by Metco is the sharply increased productivity and efficiency of the HDS3000 scanner, compared to its innovative predecessor, the Cyrax 2500. Metco has found that the HDS3000 can be used to complete the field aspects of topographic and site surveys about 50% faster. Furthermore, they have found that for many projects, the entire site survey can be conducted with just one person, instead of multi-person field crews.

What has changed so much to enable such a large jump in productivity and efficiency? Metco reports that the HDS3000's full 360° horizontal x 270° vertical field-of-view, combined with the ability to "script" or program the HDS3000 to automatically scan various parts of the site at different densities, has given them unprecedented field productivity for site surveys. The large field of view simplifies the placement of scanning targets within the site. Compared to the Cyrax 2500's 40° x 40° FOV, far fewer targets are needed and they can be placed in more convenient locations.

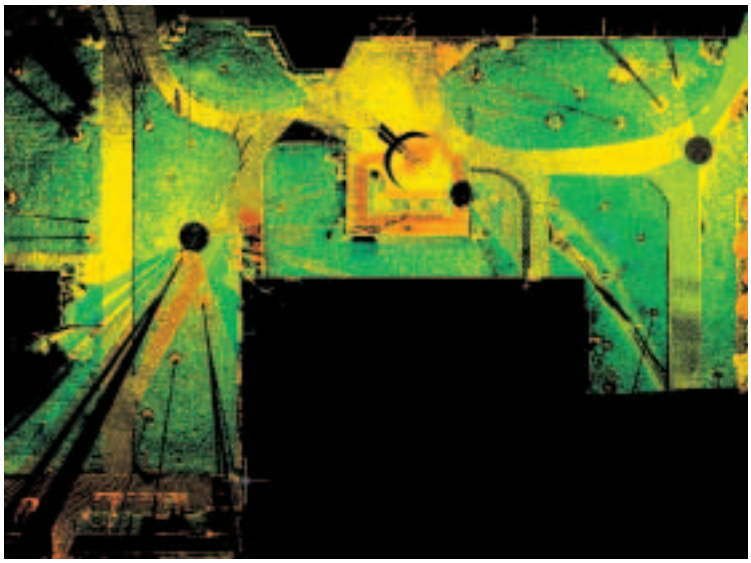
Unmanned Robotic Reflectorless Station

Metco has also found that while the HDS3000 is automatically scanning through its large field of view and scripts, the same field person can often simultaneously use one of Metco's Leica TCRA 1103 total stations to complete site survey work for objects for which the scanner is not well suited. This includes surveying scan targets for geo-referencing and/or registration and surveying points not otherwise visible to the scanner. For example, buried utilities may require lids to be lifted in order to gain access to them. These are not good candidates for scanning, but are well suited for Leica total stations. Metco is essentially using their HDS3000 as an "unmanned, robotic reflectorless station" that enables a single field person to operate two instruments at one time.

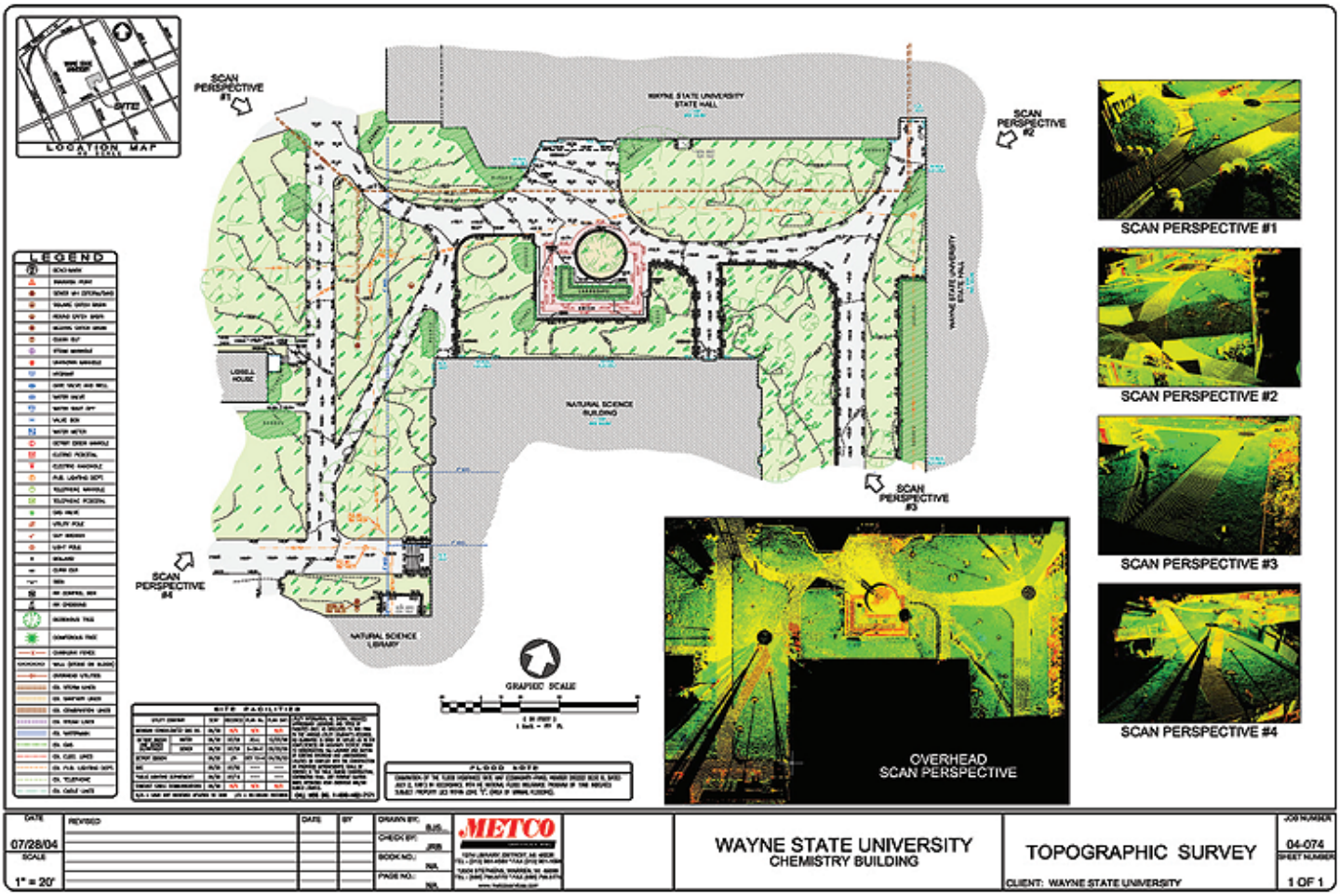
The bottom line: for many topographic or as-built surveys, instead of using a 2-person or 3-person conventional field crew, Metco can use one person with a Leica HDS3000 and Leica TCRA 1103 total station to do the total field work in about half the time.

Office Workflow Gains

The second key to Metco's success has been their refinement over time of office work procedures to convert rich point cloud data into 2D topographic or as-built drawings. Metco today uses a full suite of software tools: Leica's Cyclone software and



Laser scan images placed on 2D maps provide valuable marketing for Metco.



2D topographic survey map based on HDS3000 scan data.

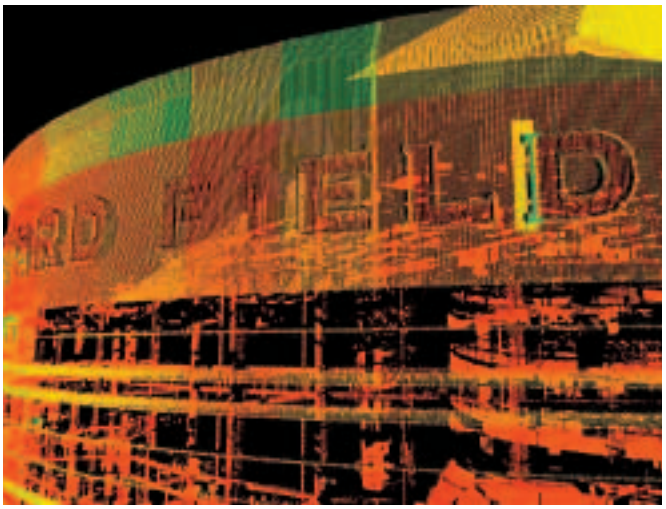
CloudWorx for AutoCAD, plus AutoCAD's Land Development Desktop software. Using the latest advances in these tools, Metco has also applied their strong understanding of how 2D maps deliverables, including line work, single point elevations, and symbols are used by clients. The result is that today, Metco is able to produce high quality 2D map deliverables for about the same office cost and time as it takes to produce such maps using conventional survey methods. Going forward, Metco sees opportunities to even further reduce their office costs for projects that include laser scanning.

Bright Future

In addition to seeing opportunities for further reducing costs and time for projects that include high-definition surveying, Metco sees opportunities to also increase client demand for high-definition surveys. For example, in order to increase client awareness of the richness and completeness of high-definition surveys, Metco today routinely incorporates scan images onto 2D map deliverables. These images replace photographs that used to occupy these spots on map deliverables. Metco has already noticed that as clients have become more aware of the richness of these surveys and the ability to re-use or re-visit high-definition survey data, clients have begun to specifically ask for high-definition surveys. This is a "win-win" for all.

Geoff Jacobs

New Leica HDS3000 scanner in use at Kennedy Square, Detroit.



Metco has used their HDS3000 scanner for site and building surveys, such as Ford Field Stadium.

Contact

You can find Leica Geosystems at numerous exhibitions, congresses and roadshows in your region. In addition, you can find information and documentation on our national websites or on www.leica-geosystems.com. There you will also find previous Reporter issues in various languages. Please visit us.

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- when it has to be **right**

Leica Geosystems